DRAFT STATEMENT OF WORK
FOR
Tiltrotor Test Rig (TTR) Slip Ring Procurement

Outline

1.0 Background

2.0 Scope of Work

3.0 System Specifications
- 3.1 Capacity
- 3.2 Dimensions
- 3.3 Configuration
- 3.4 Cable Interfaces
  - 3.4.1 Rotating wire leads
  - 3.4.2 Stationary wire leads
- 3.5 Contacts
- 3.6 Environmental Requirements
- 3.7 Performance

4.0 Tasks

5.0 Deliverables
- 5.1 Slipring
- 5.2 Documentation
  - 5.2.1 Maintenance Manual
  - 5.2.2 Mechanical Drawings

DRAFT Statement of Work
Tiltrotor Test Rig (TTR) Slip Ring Assembly

1.0 Background

NASA is completing the development of a new test bed specifically designed for evaluating rotor performance on Tiltrotor type aircraft. The Tiltrotor Test Rig (TTR) will provide the Department of Defense (DoD) and National Aeronautics and Space Administration (NASA) with the ability to test and evaluate large-scale rotors up to 26-ft diameter, turning at 0 - 630 revolutions per minute (RPM), in wind speeds up to 300 knots. The first TTR test will be a checkout of the Bell 609 rotor. It is currently scheduled for March of 2013 in the 40x80 wind tunnel of National Full-Scale Aerodynamics Complex (NFAC).

Rotating equipment (e.g. rotors and hubs) to be tested on the TTR are instrumented and must be connected to the amplifiers, filters, and power supplies of the data acquisition complex. As the units which transition electrical signals from the rotating frame to the fixed frame (sliprings) require specialized materials and construction techniques, it is in NASA's best interest to procure sliprings from companies that specialize in their development rather than attempting to construct one in-house. Similarly, as each wind tunnel test bed has unique slipring requirements, it is in NASA's best interest to procure the slipring from a company that specializes in building the type of slipring that the TTR requires. The purpose of this procurement is to present the critical specifications for the TTR slipring so that we may procure the appropriate slipring for this particular test bed.

As we have done with previous test beds, NASA will create a rotating instrumentation panel that will connect the excitation and signal wires coming from the rotating instrumentation to the wires of the rotating section of the slipring. NASA will also create the stationary interface panel that will connect the stationary section of the slipring to the facility instrumentation systems.

The size of this slipring is a critical element as it is to be located outside the TTR transmission and in between two drive shafts and plumbing for motor cooling and lubrication. Additionally, it will be sharing that inhospitable space with a rotor encoder (aka phototach), pillow block, instrumentation junction box, and the above mentioned rotating and stationary instrumentation panels. Because of this requirement NASA is seeking a slipring with very specific dimensions and environmental operating requirements.

Please see figures 1 and 2 for graphic representations of the slipring installation in the TTR. Figure 1 shows the photo of the available space on the TTR model and a diagram of the Slipring Stack (all of the equipment that NASA will be installing in conjunction with the slipring). Figure 2 shows a detailed diagram of the Slipring Stack and the dimensions allowed for each of the individual subassemblies.

Fig. 1 – TTR Model

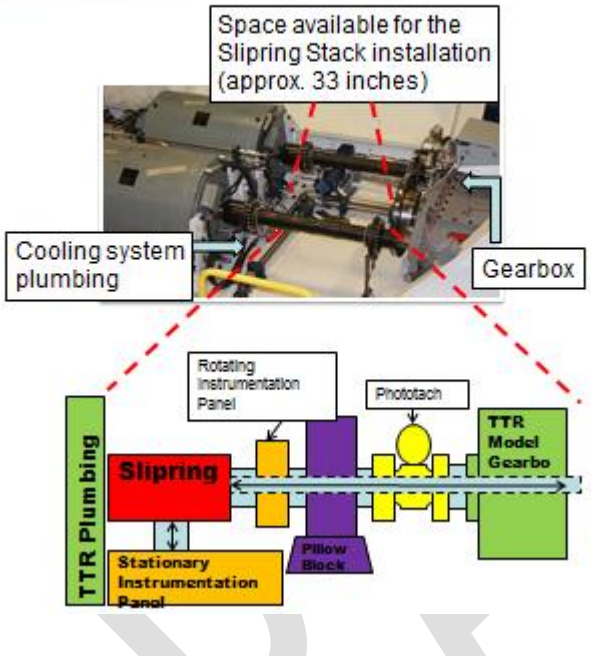
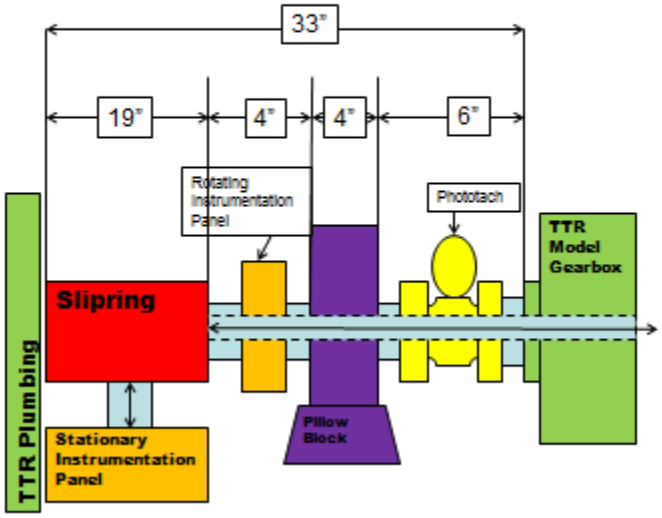


Fig. 2 - Slipring Stack



2.0 Scope of Work

The vendor is required to provide NASA with two (2) identical slipring units, which adhere to the specifications presented in section 3 and table 1.

3.0 System Specifications

NASA engineers have acquired extensive experience evaluating and operating sliprings by supporting numerous rotorcraft experiments in the wind tunnels using a wide variety of test beds. That experience, along with an understanding of the constraints imposed by the TTR design, was used to develop the following specifications (which are summarized in Table 1).

3.1 Capacity

The slipring is required to have at least 320 rings or circuits.

3.2 Dimensions

The maximum total length of the slipring hardware shall be 19 inches. The maximum outside diameter is 4 inches. These dimensions are for the overall measurements of the slipring unit and must include all hardware provided by the supplier, including the interface to the hollow shaft (see section 3.3). These dimensions do not include the wire bundles that will extend 5 feet on both the rotating and stationary portions of the slipring (see section 3.4).

3.3 Configuration

The slipring shall be designed and manufactured with bearings able to fully support its weight when mounted horizontally in a cantilevered condition. The bearings must also withstand a 1 G rotor vibration up to 10.5 Hz in the vertical and horizontal axes.

The slipring shall be a single unit, (as opposed to multiple sub-assemblies bolted together that need in-place partial disassembly) so it can be quickly and easily removed from the model without disassembly and be replaced by a spare unit.

On the rotating side of the slipring, the manufacturer has to provide an interface that will be connected to NASA's hollow shaft (see Figure 2). The hollow shaft, through that interface, will drive the rotating portion of the slipring.

3.4 Cable interfaces

The slipring shall have a rotating open-ended wire lead bundle on one end, and a stationary open-ended wire lead bundle on the opposite end. Each circuit shall have designated individual conductors that will be included in the rotating and stationary wire bundles. All wires shall meet MIL-W-22759 or -27500 standard.

3.4.1 Rotating wire leads: The rotating slipring bundle shall have a conductor dedicated to each slipring circuit. The bundle will be positioned concentrically with the center of the slipring, so it can be easily installed into the hollow rotating shaft of the TTR. Minimum 26-gage wire is required for each individual conductor. The minimum length of the open-ended rotating wire lead bundle is 5 feet. Each individual conductor shall be appropriately labeled.

3.4.2 Stationary wire leads: The stationary slipring bundle shall have a conductor dedicated to each slipring circuit. The bundle will be positioned at the opposite end of the slipring from the rotating bundle. Minimum 26-gage wire is required for each individual conductor. The minimum length of the open-ended stationary wire lead bundle is 5 feet. Each individual conductor shall be appropriately labeled.

3.5 Internal Contacts

The slipring shall use only gold-on-gold contact technology. NASA's experience is that other contact technologies (e.g. graphite-on-nickel) do not perform adequately during rotorcraft tests in the wind tunnel environment (they require much more frequent maintenance which adversely impact test schedules and costs).

3.5 Voltage/Current Capacity

Each circuit shall be rated electrically at 1 A, 20 Vdc for continuous operation.

3.6 Environmental Requirements

The slipring shall be sealed to keep the contacts free of the finely misted contaminates commonly encountered during wind tunnel experiments. The anticipated operating environment will be:

1) Air pressure of 12.7-to-14.7 psi

2) Poor air quality - permeated with engine oil mist.
3) Temperatures between 40 and 140 °F
4) Mild vibration levels (~ 1 G)

3.7 Performance

The slipring is required to:

a) Operate while mounted horizontally.
b) Operate between the range of 0 – 630 RPM, while the normal running speed is between 450-550 RPM. It shall have a minimum of 5 million revolutions operation at 500 RPM before any maintenance is required.
c) Operate without external lubrication.
d) Operate without external cooling.
e) Operate without external flushing.

4.0 Tasks

The vendor shall fully assemble, inspect and perform continuity checks on all slipring circuits prior to shipping the sliprings to NASA. Any nonconforming circuits shall be repaired or replaced prior to packaging. Initialed documentation of these checks shall be included with the slipring packages shipped to NASA (see Section 5.2.2).

5.0 Deliverables

5.1 Slipring

Two (2) sliprings as described in this specification (see section 3.0).

5.2 Documentation

5.2.1 Manuals: NASA requires a document from the manufacturer describing the installation, removal and maintenance procedures that need to be performed on the unit.

5.2.2 Slipring Checks: Initialed documentation showing that every slipring circuit has been inspected and checked for continuity.

5.2.3 Mechanical Drawings: NASA requires two sets of mechanical drawings of the final build unit. One set as a hardcopy, and one set as a digital file.

Table 1 – Specifications

Property	Specification
Length	19 inches or less
Diameter	4 inches or less
Packaging	Single unit
No. of Circuits	320 minimum
Circuit Electrical Rating	1A at 20Vdc
Installation	Horizontal in a cantilevered condition
Operating RPM range	0 - 630 RPM
Normal Operating RPM	450 – 550 RPM
Contact Technology	Gold-on-Gold
Operating temperature	40°F to 140°F
Vibration resistance	1 G at 630 RPM (cantilevered)
Sealed from oil mist	yes
Vacuum sealed	no
Horizontal installation	yes
External flushing	no
External cooling	no
External lubrication	no
Minimum revolutions at 500 RPM before service	5 million

Rotating wire leads

Length	5 feet min

Wire gage size	26 gage min
Labels	Individually labeled

Stationary wire leads

Length	5 feet min
Wire gage size	26 gage min
Labels	Individually labeled